

live in one of the little chalets up on the side of Corcovado, surrounded by the virgin forest.

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WATER PLANTS OF THE KANAWAUKE LAKES

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The Kanawauke Lakes are a group of three small lakes between Rockland and Orange Counties, New York, in the Bear Mountain-Harriman section of the Palisades Interstate Park. Only one of these, the First Lake, is natural. This was formerly known as Little Long Pond. When the other lakes were formed by damming the outlet stream in 1914 the level of the First Lake was raised about three feet. The lakes are connected by short channels some eight feet wide in the narrowest places. First Lake is about half a mile long, Second and Third Lakes a little less than one mile each. All of them are narrow and comparatively shallow. The current from First Lake through the others is slight, even in spring and early summer when the water is high, later in the season there is practically no current except that caused by the wind. On the shores of the lakes are located a group of some twenty camps where about ten thousand boy scouts spend from two to eight weeks during the summer. There is, consequently, a good deal of rowing on the lakes, while a number of motor boats make daily trips from the headquarters building at the junction of the Second and Third Lakes to each of the camps.

It would seem as if the current, supplemented by the movements of the boats, would have resulted during the ten years since the dam was built in a fairly uniform distribution of the water plants of the lakes. This is very far from being the case. The original lake has an abundant flora, the shallower water everywhere, including the areas submerged when the level was raised, being crowded with plants and the new shore line bordered uniformly by water or marsh plants. The Second Lake is almost as well supplied with plants at the end nearest First Lake, but further down the number both of species and individuals decreases. In Third Lake there are few plants, the greatest

abundance being in a bay that was a spring-fed swamp before the lake was formed. This difference is in the number of species and in abundance as well, only a few, such as *Eleocharis acicularis* and the Mermaid-weed, *Proserpinaca palustris*, being abundant in all the lakes. Thirty-seven species are found in First Lake, twenty-four in Second Lake and sixteen in Third Lake. All of the plants found in Second Lake are also found in First and all those in Third are also in both Second and First Lakes. An exception may be made in the case of *Elodea*,—formerly abundant in First Lake, it seems to have entirely disappeared from there, but has become common in Second and Third Lakes. Fifteen of the plants found are typical shore plants, growing in the water with the plant mostly above water, such as cattails, burweed, pipewort, water plantain, etc. Nine of the plants are rooted with the leaves floating or slightly raised above the surface, as water lilies, water shield, floating heart, etc. Seven of the plants are rooted and entirely submerged, as *Elodea*, most of the pondweeds and water milfoil. Six are usually free floating plants, as the purple and large yellow bladderworts, and duck weed. In First Lake the new area added by the raising of the level of the water has been occupied chiefly by the moving in of plants formerly growing in the shallow water, so that the plants are now growing under conditions similar to their original ones. A few plants have seemed unable to move and are growing under abnormal conditions. *Eleocharis Robbinsii* is found only at one point along the shore, and there in water about four feet deep, evidently where it had been growing before the level of the water was raised. Now the flowering stems reach only one or two inches above the surface, the submerged leaves, about eighteen inches long, are far below. *Peltandra virginica*, though growing commonly in shallow water along shore, is also found in places in water over three feet deep where there was originally only a swampy margin. Water milfoil, commonly floating free in great masses or rooted and the stems floating near the surface, also grows rooted in six feet of water, with the stems never reaching the surface.

The floating plants, or such as may break free and float, as the purple and yellow bladderworts, *Elodea* and naiad are the most abundant plants in Second and Third Lakes. The white water lily which is abundant in First Lake was repre-

sented in Second Lake by six scattered plants (one of these was a floating rootstalk with four leaves) and in Third Lake by two young plants. None of these in the two lower lakes had blossomed in 1924 as far as could be ascertained. In this case at least, there seems to be something either in the water or the soil of the bottom that has prevented the plant from getting a foothold, as several attempts have been made to transplant mature plants from First Lake to the others. The yellow water lily has succeeded better, as there were nearly a score of plants in Second Lake and eight in Third and in each lake several of the plants were in blossom this year. Other plants that seem especially well fitted for dispersal under the conditions, such as the floating heart with its slender stems with clusters of roots developed a short distance below the leaves, have not been found in either of the lower lakes.

When the level of Little Long Pond was raised, in two places masses of boggy soil broke loose and floated. These floating islands, anchored by the roots of shrubs, are the only places around the lakes where such bog plants as cranberry, round-leaved and intermediate sundew and pitcher plants grow. Their margins are bordered by the water loosestrife, *Decodon verticillata*, the long slender stems dipping into the water where they form a thick growth of spongy, air-holding bark, develop a few floating roots, then rise again into the air. Occasionally this process is repeated a second and even a third time, the plant then consisting of a series of two or three leafy loops separated by submerged portions. This plant also should be easily transported to other parts of the lakes as portions of the root bearing stems are easily broken off and may start new clumps of the plant, but no plants have been found anywhere around the lakes except on the margins of these islands.

Dr. Gilbert Morgan Smith* in discussing the plankton algae of these lakes refers to the much greater algal flora in the Second and Third Lakes. At the time of his investigations these two lakes "bloomed" profusely in August. Dr. Smith suggested that as the vegetable matter submerged when the lakes were formed gradually disappeared by decay and the water assumed a more stable chemical condition and approached the conditions

* Gilbert Morgan Smith, Ecology of the Plankton Algae in the Palisades Interstate Park, Roosevelt Wild Life Bulletin, Vol. 23, No. 4, Feb. 1924.

of Little Long Pond the great number of Blue Green Algae would tend to disappear. This seems to have been already accomplished. The two lakes "bloomed" freely in 1921, slightly in 1922 and not at all in 1923 or 1924. Of course there were floating algae of various kinds in the lakes but nothing approaching the conditions of a "bloom." In the two lower lakes there are a few areas where considerable amounts of *Oscillatoria* are found on the bottom in August but none of this was noticeable in First Lake. If this indicates a decrease in the amount of organic matter in the lake water and an approach to what may be considered the normal composition, it suggests that some plants which have not secured a foothold in these lakes may find suitable conditions in the next few years and become established there. That the nature of the bottom can not be the chief restricting factor is evidenced by the abundant growth on the submerged shores of Little Long Pond.

The plants collected during the past three years are the following:

PLANTS FOUND IN ALL THREE LAKES

- Typha latifolia* L., not abundant on any of the shores.
Sparganium eurycarpum Engelm., common on all the lakes.
Potamogeton heterophyllus Schreb. *Forma graminifolius* (Fries)
 Morong, common in First and Second Lakes, a few widely scattered plants in Third Lake.
Najas flexilis (Willd.) Rostk. & Schmidt. Very common in shallow water.
Elodea canadensis Michx. Common in Second and Third Lakes, formerly common in First Lake.
Vallisneria spiralis L. A few plants in water from two to four feet deep in all lakes.
Eleocharis acicularis (L.) R. & S. Common about the shores and in water up to a foot in depth.
Pontederia cordata L. Common about First Lake, only four plants found on Second and one on Third Lake.
Nymphaea advena Ait. Not uncommon in First Lake, few in the others.
Castalia odorata (Ait.) Woodville & Wood. Common in First, few in Second and only two plants in Third Lake.
Brasenia Schreberi Gmel. Common in First Lake, a few in most parts of Second, common near inlet of Third.

Hypericum virginicum L. Common about the shores of First and Second, uncommon on Third Lake.

Myriophyllum scabratum Michx. Abundant in First Lake, common in the others.

Proserpinaca palustris L. Common about all the lakes.

Utricularia purpurea Walt. Abundant in First Lake, common in Second, a few plants in Third Lake.

U. vulgaris L. Uncommon about all the lakes.

PLANTS FOUND IN FIRST AND SECOND LAKES

Typha angustifolia L. A few plants near shore in both lakes.

Potamogeton natans L. Few plants in First, one only found in Second Lake.

P. zosterifolius Schumacher. Few in First Lake, one plant found near the inlet in Second Lake.

Sagittaria longirostra (M. Michell) J. G. Sm. Not common.

Alisma Plantago-aquatica L. Not common about First Lake, one plant found on Second.

Dulichium arundinaceum (L.) Britton. Few plants.

Peltandra virginica (L.) Kunth. Common about both lakes.

Utricularia subulata L. Uncommon.

PLANTS FOUND ONLY IN FIRST LAKE

Equisetum fluviatile L. In marsh bay at end of lake.

Potamogeton dimorphus Raf. Few plants with submerged fruit only.

P. filiformis Pers. Few plants.

P. interruptus L. Not uncommon.

Sagittaria graminea Michx. Few plants, none in flower.

Eleocharis Robbinsii Oakes. In four feet of water near one shore.

Spirodela polyrhiza (L.) Schleid. Common in quiet bays.

Eriocaulon articulatum (Huds.) Morong. Not common in shallow water, sometimes in water eighteen inches deep.

Decodon verticillatus (L.) Ell. On margins of floating islands.

Proserpinaca pectinatus Lam. Few submerged plants.

Nymphoides lacunosum (Vent.) Fernald. Not uncommon in water from six inches to six feet deep.

Myosotis laxa Lehm. In shallows, at end of lake.

Utricularia intermedia Hayne. Floating in company with *myriophyllum* and *U. purpurea*, no flowers found.

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